

AMENDMENTS TO THE SPECIFICATION

Insert the following section immediately following the title on page 1:

Cross-Reference to Related Application

This is a continuation of co-pending application Serial Number 08/997,774 filed December 24, 1997 with a CPA filed November 21, 2000, now abandoned.

Replace the paragraph at page 1, lines 5-20, with the following amended paragraph:

The present invention relates to an improved catalytic converter system for the treatment of the exhaust gases from internal combustion engine powered vehicles, and to methods of making and using the same. More specifically, the invention is concerned with catalytic converter systems comprising the combination of a hydrocarbon adsorbent material or "trap" and a low light-off temperature, precious metal catalyst disposed under the floor of an internal combustion engine powered vehicle at the muffler position or at the tailpipe position, where the temperature of the exhaust gas contacting the catalyst will be lower than about 550°C, and preferably lower than about 500°C. The invention is also concerned with catalytic converter systems which combine a hydrocarbon adsorbent material and a low light-off temperature catalyst material so as to achieve ultra low levels of emissions for internal combustion engine powered vehicles, especially during the cold-start period of operation.

Replace the paragraph at page 3, lines 8-11, with the following amended paragraph:

U.S. Patent No. 4,780,447 discloses a catalyst which is capable of controlling HC, CO and NO_x, as well as ~~H₂S~~ H₂S, in automobile emissions. The use of the oxides of nickel and/or iron is disclosed as an H₂S gettering compound.

Replace the paragraph at page 5, lines 1-23, with the following amended paragraph:

In order to improve the emissions performance achievable by conversion catalyst compositions, particularly during cold-start operation, it has been proposed to heat the catalyst other than by simply passing very hot exhaust gases over the catalyst. For example, it has been proposed to electrically heat conversion catalysts during at least the first few minutes of operation after starting a cold engine. It also has been proposed to use an adsorbent material to adsorb hydrocarbons during the cold-start period of engine operation. The adsorbent material typically would be located downstream of a TWC catalyst such that the exhaust stream would first flow through the catalyst material and then through the adsorbent ~~material~~. The adsorbent, often referred to as a "trap", preferentially would adsorb hydrocarbons over water under the conditions present in the exhaust stream. After a period of time the adsorbent would have reached a temperature, e.g., about 150°C, at which it no longer would be able to adsorb hydrocarbons from the exhaust stream. At that temperature, referred to as the desorption temperature (T_D), hydrocarbons would begin to desorb from the adsorbent and would be directed into contact with the conversion catalyst. The desorbed hydrocarbons then would be converted by the heated catalyst. The desorption of the hydrocarbons from the adsorbent material regenerates the adsorbent for use during a subsequent cold start.

Replace the paragraph at page 5, lines 1-23, with the following amended paragraph:

These and other objects and advantages of the present invention are achieved by providing a catalytic converter system which combines at least one low light-off temperature precious metal conversion catalyst and a hydrocarbon adsorbent or trap selectively arranged downstream of an internal combustion engine such that the catalyst ~~material~~ never is exposed to a temperature in excess of about 550°C. Preferably, the catalyst is never exposed to a temperature in excess of about 500°C; and most preferably, the catalyst is never exposed to a temperature above about 480°C.

Replace the paragraph at page 7, lines 7-20, with the following amended paragraph:

While the use of hydrocarbon adsorbent materials in combination with catalyst compositions has been proposed, there remains a need for improved integrated adsorbent/catalyst systems which are capable of reducing noxious emissions from internal combustion engine powered vehicles, especially automobiles, while being located relative to the vehicle engine such that the catalyst never reaches a temperature in excess of about 550°C, preferably such that the catalyst never reaches a temperature in excess of about 500°C, and most preferably such that the catalyst never reaches a temperature in excess of about 480°C. This will enable the use of more economical materials of construction for the converter system components and will increase the useful life of temperature sensitive catalyst ~~materials~~.

Replace the paragraph at page 10, lines 6-28, with the following amended paragraph:

As illustrated schematically in Figure 1, it is conventional practice to locate a pollutant conversion catalyst 10 under the floor of an internal combustion engine powered vehicle, such as an automobile, at a location downstream of the engine 11 and considerably upstream of a muffler 12 and tailpipe 13. Conversion catalyst 10 preferably comprises a catalyst ~~material~~—also referred to as a first or upstream catalyst ~~material~~—which is preferably a TWC catalyst composition. The catalyst ~~material~~ is preferably supported on a substrate such as a ceramic or metal honeycomb monolith. The conversion catalyst will be contacted with an engine exhaust gas stream having a temperature typically in excess of about 650°C, e.g., about 1000°C and containing noxious components or pollutants including unburned or thermally degraded hydrocarbons or other similar organics. Other noxious components usually present in the exhaust gas stream include nitrogen oxides and carbon monoxide. The engine 11 may be fueled by a hydrocarbonaceous fuel, which in this specification and in the appended claims, is meant to include hydrocarbons, alcohols and mixtures thereof. Examples of hydrocarbons which may be used to fuel the engine include gasoline and diesel fuel. Alcohols that may be used to fuel the engine include, for example, ethanol and methanol. Mixtures of alcohols and mixtures of alcohols and hydrocarbons also may be used.

Replace the paragraph at page 11, lines 4-11, with the following amended paragraph:

During this cold-start period, the temperature of the first catalyst ~~material~~—of conversion catalyst 10 generally is below its light-off temperature (T_L), i.e., the temperature at which the catalyst ~~material~~ attains fifty percent conversion performance. Accordingly, during the cold-start period, a substantial portion of the pollutants in the exhaust

gas stream typically pass directly through the catalyst 10 and out of the tailpipe 13 and into the atmosphere.

Replace the paragraph at page 11, lines 12-37, with the following amended paragraph:

In accordance with one embodiment of the present invention, as illustrated schematically in Figure 2, a precious metal, low temperature conversion (LTC) catalyst 20, comprising a low temperature conversion catalyst ~~material~~ having a light-off temperature below about 200°C, and preferably below about 100°C, e.g., about 70°C. The low temperature catalyst ~~material~~ is preferably supported on a substrate such as a ceramic or metallic honeycomb monolith. The LTC catalyst 20 is located downstream of an internal combustion engine 11 to avoid emitting unconverted pollutants into the atmosphere. The LTC catalyst 20 is located downstream of the engine 11 at or near the position that is typically occupied by a muffler 12 and where the temperature of the engine exhaust gas stream is less than about 550°C, and preferably less than 500°C. The LTC catalyst 20 may be used as the sole conversion catalyst. However, in certain aspects of the invention, the LTC catalyst 20 will be used in conjunction with a conventional pollutant conversion catalyst 10 to ensure that the level of pollutant compounds exhausted to the atmosphere will be at an ultra low level, e.g., less than about 0.04 g/mile for hydrocarbons, less than about 1.7 g/mile for carbon monoxide, and less than about 0.2 g/mile for nitrogen oxides. In either case, however, the LTC catalyst 20 will be located toward the conventional muffler position (Figure 2), or the tailpipe position (Figure 3), where the temperature of the exhaust gas stream is relatively low, i.e., less than about 550°C, and preferably less than about 500°C, e.g., about 300°C.

Replace the paragraph at page 11, line 38 to page 12, line 13, with the following amended paragraph:

The catalyst ~~material~~ of conversion catalyst 10 that optionally may be used as part of the present converter system may comprise any of the catalyst materials known in the art for converting the pollutants in an internal combustion engine exhaust stream to innocuous compounds. Conversion catalyst 10 is preferably a three-way catalyst (TWC). Typically, the catalyst 10 comprises a platinum group metal deposited on a refractory support material. The support material may comprise a high surface area refractory oxide, such as zirconia, ceria, titania, or the like. In one preferred embodiment, the support material may comprise alumina generally referred to in the art as "gamma alumina" or "activated alumina", which typically exhibits a BET surface area in excess of about 60 square meters per gram (m^2/g), often up to about 200 m^2/g or more. Such activated alumina is usually a mixture of the gamma and delta phases of alumina, but also may contain substantial amounts of eta, kappa and theta alumina phases.

Replace the paragraph at page 12, lines 14-27, with the following amended paragraph:

As is known in the art, the support material may be stabilized against thermal degradation. For example, when the support material is activated alumina, materials such as zirconia, titania, alkaline earth metal oxides such as baria, calcia or strontia, or rare earth metal oxides such as ceria, lanthana and mixtures of two or more rare earth metal oxides, may be added to the alumina to render the support stable at relatively higher temperatures. See, for example, U.S. Patent 4,171,288. For a discussion of other support materials that may be used for the catalyst ~~material~~-1, see application Serial No. 08/682,174 (Docket No. 3777D), filed, July 16, 1996. That application, which is entitled,

"VEHICLE HAVING ATMOSPHERE POLLUTANT TREATING SURFACE", and which is assigned to the assignee of this application, is incorporated herein by reference.

Replace the paragraph at page 13, lines 7-16, with the following amended paragraph:

The catalyst ~~material~~-of conversion catalyst 10 that may be used in the present invention may be employed in particulate form with particles in the micron-size range typically 1-20 microns, and more typically, about 10-20 microns in diameter. The particles may be formed into any convenient shape, such as pellets, granules, rings, spheres or short, extruded segments. In the alternative, the catalyst particles can be deposited, e.g., as a film or washcoat, onto a carrier material, preferably an inert monolithic carrier material, which provides a structural support for the catalyst ~~material~~-of conversion catalyst 10.

Replace the paragraph at page 13, line 30 to page 14, line 16, with the following amended paragraph:

The carrier material may best be utilized in a rigid configuration, such as a honeycomb-type configuration having a plurality of fine, parallel gas-flow passages or channels extending therethrough in the direction of gas flow from an inlet to an outlet face of the carrier. It is preferred that the configuration be a honeycomb-type configuration, either in a unitary form, or as an arrangement of multiple components or modules. When used, a honeycomb structure typically would be oriented such that the exhaust gas stream flows in the same direction as the cells or channels of the honeycomb structure. Typically, the flow passages or channels would be essentially straight from their fluid inlet to their fluid outlet, and would be defined by walls on which the catalyst ~~material~~-10 would be coated as a "washcoat" so that the gases flowing

through the passages contact the catalyst ~~material~~. The flow passages of the carrier member are thin-walled channels which can be of any suitable size and cross-sectional shape, e.g., trapezoidal, rectangular, square, oval, circular, hexagonal, sinusoidal or the like. Such honeycomb-type carriers may contain from about 60 to about 1200 or more gas inlet openings ("cells") per square inch of cross section (cpsi), more typically 200 to 600 cpsi. Generally, the coated carrier is disposed in a canister configured to protect the catalyst ~~material~~ and to facilitate establishment of a gas flow path through the cells and in contact with the catalyst ~~material~~, as is known in the art. For a more detailed discussion of monolithic structures, refer, for example, to U.S. Patent Nos. 3,785,998 and 3,767,453.

Replace the paragraph at page 14, line 17 to page 15, line 3, with the following amended paragraph:

In one embodiment, as illustrated in Figure 4, the catalyst ~~material~~ of conversion catalyst 10 is preferably supported on a honeycomb-type carrier member 30 of generally cylindrical shape having a cylindrical outer surface 31, a first or inlet end face 32 and a second or outlet end face, not visible in Figure 4, which is identical to inlet end face 32. The junction of the outer surface 31 and the outlet end face at its peripheral edge portion is indicated as 33 in Figure 4. As shown more clearly in Figure 5, the carrier 30 has a plurality of fine, parallel gas flow passages 34 formed therein. The gas flow passages 34 are defined by walls 35 and extend through the carrier 30 from inlet end face 32 to the outlet end face thereof, the passages 34 being unobstructed so as to permit the flow of a fluid, e.g., exhaust gas stream, longitudinally through the carrier via the gas flow passages 34 thereof. A coating 36, which in the art is sometimes referred to as a "washcoat", is adhered to the walls 35 and may be comprised of a single layer of the catalyst ~~material~~, or multiple layers of the same or different catalyst ~~materials~~.

The washcoat may be deposited onto the walls 35 of the honeycomb carrier by first mixing the catalyst ~~material~~ with water and a binder to form a washcoat slurry, followed by dipping the carrier into the slurry, removing excess slurry by draining or blowing out the channels of the honeycomb, and heating the coated honeycomb to drive off the water and to harden the resulting catalyst layer. The above process could be repeated, as necessary, to achieve the desired loading ~~of catalyst material~~ of conversion catalyst 10 on the carrier.

Replace the paragraph at page 15, lines 4-10, with the following amended paragraph:

In an alternative embodiment, not shown in the drawings, the catalyst ~~material~~ 10 may be supported on a carrier material comprised of a body of beads, pellets or particles (collectively referred to as "carrier beads") made of a suitable refractory material such as gamma-alumina. A body of such carrier beads may be contained within a suitable perforated container that permits the passage of an exhaust gas stream therethrough.

Replace the paragraph at page 15, lines 11-22, with the following amended paragraph:

When deposited as a washcoat onto a carrier, the amounts of the various components ~~of the catalyst material~~ of conversion catalyst 10 are often presented on a grams per volume basis, e.g., grams per cubic foot (g/ft^3) for platinum group metal components and grams per cubic inch (g/in^3) for catalytic materials generally, as these measures accommodate different gas flow passage sizes in different carriers, e.g., different cell sizes in honeycomb-type carriers. For typical automobile exhaust gas catalytic converters, the ~~catalyst material~~ of conversion catalyst 10,

when used, generally comprises from about 1.0 to about 5.5 g/in³, generally from about 2.0 to about 4.5 g/in³ of catalytic material washcoat on the carrier.

Replace the paragraph at page 15, lines 23-26, with the following amended paragraph:

Typically, the ~~catalyst material of conversion~~ catalyst 10 functions as a TWC catalyst suitable for the conversion of hydrocarbons, carbon monoxide and nitrogen oxides to innocuous substances, e.g., H₂O, CO₂ and N₂.

Replace the paragraph at page 15, line 27 to page 16, line 5, with the following amended paragraph:

As illustrated in Figures 2 and 3, the present catalytic converter system optionally, although preferably, comprises a hydrocarbon adsorbent or trap 40 comprising a hydrocarbon adsorbent material. Preferably, the trap is located downstream of the optional upstream conversion catalyst 10 and upstream of the low temperature catalyst 20. The trap 40 is designed to adsorb hydrocarbons from the exhaust gas stream while the engine is warming-up and to desorb the previously adsorbed hydrocarbons when the LTC catalyst 20 has reached a temperature above its light-off temperature. It will be appreciated, of course, that one or more additional adsorbent materials, e.g., for adsorbing-desorbing carbon monoxide, nitrogen oxides, water and/or sulfur dioxide optionally may be included in the system, as described in application Serial No. ~~(not yet available)~~ ~~(Docket No. 3754)~~ 08/987,232, filed on even date herewith. That application ~~(Docket No. 3754)~~, which is entitled, "NEAR ZERO EMISSION VEHICLE CATALYTIC CONVERTER SYSTEM FOR INTERNAL COMBUSTION ENGINE POWERED VEHICLES", is assigned to the assignee of this application and the disclosure thereof is incorporated herein by reference.

Replace the paragraph at page 16, lines 6-14, with the following amended paragraph:

The low temperature conversion catalyst 20 that is used in the present invention may comprise any low temperature conversion catalysts material that is capable of converting the pollutants in an internal combustion engine exhaust gas stream to innocuous compounds, and which has a light-off temperature less than about 200°C, and preferably less than about 100°C, e.g., about 70°C. Such low temperature conversion catalyst materials are disclosed in the above mentioned application Serial No.08/682,174 (~~Docket No. 3777D~~).

Replace the paragraph at page 16, lines 15-34, with the following amended paragraph:

There is no limit on the efficiency of the LTC catalyst ~~material of low temperature conversion catalyst 20~~ as long as it is capable of causing the desired conversion reactions to take place. Useful conversion efficiencies are preferably at least about 10% and more preferably at least about 20%. Preferred conversions depend on the particular pollutants being treated. For example, preferred conversion for carbon monoxide is greater than 10% and preferably greater than 30%. Preferred conversion efficiency for hydrocarbons and partially oxygenated hydrocarbons is at least 5%, preferably at least 15%, and most preferably at least 25%. Preferred conversion efficiency for nitrogen oxides is at least 5%, preferably at least 15%, and most preferably at least 25%. These conversion rates are particularly preferred where the temperature of the exhaust gas stream contacting the catalyst surface is at less than about 550°C. These temperatures typically are experienced during normal engine operation when the catalyst is located in the muffler or tailpipe

position. The conversion efficiency is based on the mole percent of the particular pollutants in the exhaust gas stream which react in the presence of the LTC catalyst composition.

Replace the paragraph at page 16, line 35 to page 17, line 35, with the following amended paragraph:

LTC catalysts ~~materials~~ which are useful for converting carbon monoxide to carbon dioxide preferably comprise at least one precious metal component, preferably selected from platinum, rhodium and/or palladium components with platinum components being most preferred. A combination of a platinum component and a palladium component results in improved CO conversion at an increase in cost and is most preferred where greater conversion is desired and cost increase is acceptable. The LTC catalyst compositions for converting carbon monoxide to carbon dioxide typically comprise from about 0.01 to about 20 weight percent, and preferably from about 0.5 to about 15 weight percent of the precious metal component on a suitable support such as refractory oxide support, with the amount of precious metal being based on the weight of precious metal (metal and not the metal component) and the support. Platinum is most preferred and is preferably used in amounts of from about 0.01 to 10 weight percent and more preferably 0.1 to 5 weight percent, and most preferably 1.0 to 5.0 weight percent. Palladium is useful in amounts from about 2 to about 15, preferably about 5 to about 15, and yet more preferably about 8 to about 12 weight percent. The preferred support is titania, with titania sol being most preferred. When loaded onto a monolithic structure such as a honeycomb refractory carrier, the catalyst loading is preferably about 1 to 150, and more preferably 10 to 100 grams of platinum per cubic foot (g/ft^3) of catalyst volume and/or 20 to 1000 and preferably 50 to 250 grams of palladium per cubic foot of catalyst volume. A preferred composition comprises about 50 to 90 g/ft^3 of platinum and 100 to 225 g/ft^3 of palladium. Preferred catalysts are reduced.

Conversions of about 30 to about 100 mole percent of carbon monoxide to carbon dioxide can be achieved using a coated honeycomb refractory carrier having from about 1 to about 5 weight percent (based on metal) of platinum on titania compositions at temperatures from 25°C to 100°C, where the carbon monoxide concentration in the exhaust stream being treated was 10 to 10,000 parts per million and the space velocity was 20,000 to 50,000 reciprocal hours. Conversions of about 0 to 70 mole percent of carbon monoxide to carbon dioxide can be attained using 1 to 5 weight percent platinum on alumina support compositions at a temperature of from about 50°C to about 100°C, where the carbon monoxide concentration is about 10 parts per million and the space velocity is about 20,000 reciprocal hours.

Replace the paragraph at page 17, line 36 to page 18, line 26, with the following amended paragraph:

LTC catalysts ~~materials~~ for converting hydrocarbons, typically unsaturated hydrocarbons, more typically unsaturated mono-olefins having from two to about twenty carbon atoms and, in particular, from two to eight carbon atoms, and partially oxygenated hydrocarbons, comprise at least one precious metal component, preferably selected from platinum and palladium with platinum being most preferred. The combination of a platinum component and a palladium component results in improved hydrocarbon conversion at an increase in cost and is most preferred where greater conversion is desired and cost increase is acceptable. Useful catalyst compositions include those described for use to treat carbon monoxide. Compositions for treating hydrocarbons typically comprise from about 0.01 to about 20 wt.%, and preferably 0.5 to 15 wt.%, of the precious metal component on a suitable support such as a refractory oxide support, with the amount of precious metal being based on the weight of the precious metal, (not the metal component) and the support. Platinum is the most preferred and is preferably used in amounts of from 0.01 to

10 wt.%, more preferably 0.1 to 5 wt.%, and most preferably 1.0 to 5 wt.%. When loaded onto a monolithic structure such as a refractory honeycomb carrier of the type illustrated in Figure 4, the catalyst loading is preferably about 1 to about 150 and more preferably about 10 to about 100 grams of platinum per cubic foot (g/ft^3) of catalyst volume. When platinum and palladium are used in combination, there is from about 25 to 100 g/ft^3 of platinum and 50 to 250 g/ft^3 of palladium. A preferred composition comprises about 50 to 90 g/ft^3 of platinum and 100 to 225 g/ft^3 of palladium. The preferred refractory oxide support is a metal oxide refractory that is preferably selected from ceria, silica, zirconia, alumina, titania and mixtures thereof with alumina and titania being most preferred. The preferred form of titania is a titania sol.

Replace the paragraph at page 18, lines 27 to 39, with the following amended paragraph:

LTC catalysts ~~materials~~ useful for the oxidation of both carbon monoxide and hydrocarbons generally include those recited above as useful for treating either carbon monoxide or hydrocarbons. Most preferred catalysts that have been found to have good activity for the treatment of both carbon monoxide and hydrocarbons, such as unsaturated olefins, comprise a platinum component supported on a preferred titania support. Such catalyst compositions preferably comprise a binder and can be coated on a suitable support structure in amounts of from about 0.5 to about 1.0 g/in^3 . A preferred platinum concentration ranges from 2 to 6% and preferably 3 to 5% by weight of platinum metal on the titania support. Useful and preferred substrate cell densities are equivalent to about 200 to 600 cpsi .

Replace the paragraph at page 21, line 38 to page 22, line 8, with the following amended paragraph:

As shown in Figures 2 and 3, a trap 40 is disposed downstream of the catalyst material-10 for adsorbing hydrocarbon pollutants during the cold-start period of engine operation. A single trap containing an appropriate adsorbent material for reversibly adsorbing-desorbing hydrocarbons is shown. However, it will be appreciated that additional traps may be employed for adsorbing other pollutants, and that the adsorbents may be selected such that the adsorbed pollutants become desorbed, thereby regenerating the adsorbents, once the optional catalyst material-10, or the LTC catalyst 20, has warmed sufficiently to convert efficiently the pollutants contained in the exhaust gas stream.

Replace the paragraph at page 22, lines 9-16, with the following amended paragraph:

Adsorbents for hydrocarbons and other pollutants in the exhaust gas stream are not novel, *per se*; and they do not, in and of themselves, comprise the present invention. It is the use and location of such adsorbents, in combination with an appropriate low temperature conversion (LTC) catalyst material-20, and the location of the LTC catalyst at a position where the temperature of the exhaust gas stream does not exceed about 550°C, and preferably 500°C that comprises the invention.

Replace the paragraph at page 24, line 8 to page 25, line 7, with the following amended paragraph:

The carrier material may best be utilized in a rigid configuration, such as a honeycomb-type configuration, as described above in connection with the refractory carriers on which the catalyst material-10 and the

LTC catalyst 20 may be coated. When the hydrocarbon adsorbent is coated on a honeycomb-type carrier, it may be coated on a carrier that is separate from that which the catalyst ~~material~~-(10) or the LTC ~~material~~-(20) is coated. In that case, the hydrocarbon adsorbent material may be described as comprising at least a portion of the trap 40 shown in Figures 2 and 3. However, in certain alternative embodiments of the invention, the same honeycomb-type carrier may be coated with either or both of the catalyst ~~material~~-(10) and the LTC catalyst ~~material~~-(20), and also with the hydrocarbon adsorbent material (40). In those embodiments, as illustrated, for example, in Figure 6, the catalyst ~~material~~-25 including at least one layer of the catalyst ~~material~~-(10) and/or at least one layer of the low temperature catalyst ~~material~~-(20) and the hydrocarbon adsorbent material 45 may be applied, for example, as separate washcoat layers 25 (catalyst-~~material~~) and 45 (hydrocarbon adsorbent material or trap material) respectively, on the walls 35 of the honeycomb cells, in the manner described above in connection with the catalyst 10. Typically, when the catalyst ~~material~~-(20) and the hydrocarbon adsorbent material (40) are applied as separate layers on the same honeycomb-type carrier, the catalyst layer 25 is deposited on top of the adsorbent layer 45 as a porous overlayer. To provide a suitably porous overlayer, the total loading of catalyst material overlying the adsorbent material preferably does not exceed about 5 g/in³. For example, the catalyst layer 20 may be applied at a loading of from about 2 to 4.5 g/in³, preferably about 3.5 g/in³. In addition to providing a permeable catalytic overlayer, the application of loadings of ~~catalytic material~~catalyst in this range will avoid imparting a significant pressure drop in the exhaust gas stream flowing through the honeycomb carrier member. Typically, the hydrocarbon adsorbent material 40 is coated onto the carrier at a loading of from about 0.4 to about 3.0 g/in³. Optionally, the overlayer of catalyst ~~material~~-20 may be coated onto the carrier as a series of two or more discrete layers of the same

or different catalyst~~material~~, one upon the next, over, under, or between one or more discrete layers of hydrocarbon adsorbent material 45.

Replace the paragraph at page 25, lines 8-14, with the following amended paragraph:

In an alternative embodiment, not shown in the drawings, the hydrocarbon adsorbent material (40) may be deposited on a particulate carrier, referred to as "carrier beads". As described above in connection with the catalyst ~~material~~ (10), a body of such carrier beads may be contained within a suitable perforated container which permits the passage of an exhaust gas stream therethrough.

Replace the paragraph at page 25, lines 1-23, with the following amended paragraph:

It is desirable to optimize the amount of hydrocarbon adsorbent that is used such that the catalyst ~~material~~ (20) downstream of the hydrocarbon adsorbent is heated as quickly as possible while at the same time ensuring that at least about 50% of the hydrocarbons in the exhaust stream are adsorbed on the hydrocarbon adsorbent. It is preferred that the adsorbent be deposited on a monolithic honeycomb carrier in order to minimize the size of the adsorbent mass and the back pressure exerted on the engine.